REMARKS

Claims 1-119 are pending in this application, and claims 30, 40-115, and 117-119 have been withdrawn from consideration, due to a restriction requirement. Claims 1-29, 31-39, and 116, have been rejected as being anticipated or obvious in view of the references cited by the Examiner.

In response Applicants have amended the claims to more clearly distinguish the invention. In particular, Applicants have amended claim 1, cancelled claims 8,16, and 38, amended claim 9 to depend from amended claim 1 instead of cancelled claim 8, and amended claims 14, 15, and 31. In addition Applicants have added new dependent claims 121 and 122, which are related to claims 14 and 15.

Claim 1 has been amended to read as follows:

A method for treating a material, comprising:

forming an ozone-solvent solution at a first temperature; and
reacting the ozone-solvent solution with the material at a second temperature;

wherein the first temperature is less than the second temperature, the relatively lower first temperature facilitating an increased concentration of dissolved ozone in the solvent, the relatively higher second temperature facilitating an increased reaction rate between the ozone-solvent solution and the material; <u>and</u>

<u>wherein the reacting step comprises:</u>
<u>heating said ozone-solvent solution from said first temperature to substantially said second temperature to form a heated ozone-solvent solution; and</u>
<u>after said step of heating said ozone-solvent solution, applying said heated ozone-solvent solution to the material at said second temperature</u>.

This amended claim 1 is essentially the same as cancelled claim 8, but with the added emphasis that the step of applying the heated ozone-solvent solution takes place <u>after</u> the step of heating the ozone-solvent solution. In cancelled claim 8, this time ordering of steps was there, in that the language said " applying said <u>heated</u> ozone-solvent solution to the material at said second temperature." (emphasis added) Clearly, the step of applying had to be after the step of heating, since it was the "heated" ozone-solvent solution that was being applied. Nevertheless, to eliminate any possible confusion, Applicants have added the language "after said step of heating said ozone-solvent solution." (This same kind of amendment was made to claim 31 to clearly delineate the time ordering of the steps.)

One of the motivations for this amendment of claim 1 was Examiner's rejection of claim 8, which was stated as follows: "... (Nelson reference)'551 discloses the step of heating the ozone solvent solution from the cooler first temperature to the warmer second temperature and applying solution to the wafer at the second temperature. Specifically, at column 8, line 23, *et seq*. '551 discloses that a heated liquid and the processing liquid ... may be caused to contact the substrate simultaneously... The simultaneous application of the fluids necessarily would result in, at least a partial mixing, and associated heat exchange, of the fluid prior to actual delivery to the surface of the substrate."

In response, Applicants respectfully traverse the Examiner with respect to this interpretation of Nelson. In particular, it is the teaching of Nelson that the process fluid and the DI water hit the wafer simultaneously (i.e. " at the same time "). That means that both fluids have been applied to the surface at the same time, and even if there is mixing on the surface of the wafer that heats the process fluid, it will have been heated after it has been applied to the wafer, not prior to when it was applied to the surface. It is not the teaching of Nelson that the two fluids are mixed before they are applied to the surface, either. For example, in Nelson, column 16, claim 1, recites

> "a method of treating a substrate comprising the steps of causing a heated liquid to contact the substrate in a manner effective to heat a least a portion of the substrate; and
> causing a processing liquid to contact the heated substrate,
> wherein the processing liquid comprises a heat sensitive agent at least partially dispersed or dissolved in a solvent,
> and wherein the processing liquid and the heated liquid are provided as separate liquids." (emphasis added)

Also, in Figures of the Nelson reference, the process fluid and the heating fluid have separate tubes through which the fluids are applied to the wafers. There is no "mixing chamber" for the fluids to be mixed before they are applied to the surface, and there is no teaching in Nelson of mixing before application of the fluids.

> Further, in the abstract of the Nelson reference it is stated:
> " the present invention provides a method for treating a substrate, or a plurality of substrates, so that the treatment thereof is enhanced. In particular, the method includes the steps of causing a heated liquid to contact the substrate(s) and causing a processing liquid to contact the substrate(s). Although the processing liquid comprises a heat sensitive agent, the effectiveness of the processing liquid is not substantially diminished by the application of the heat due to the fact that the heat is applied by the application of a separate heated liquid rather than by heating the processing liquid itself." (emphasis added)
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> This is clearly a teaching away from Applicants' claimed invention.

Further, the importance of this invention relative to the Nelson process, cannot be overemphasized. For example, the Nelson process in which a heated liquid is applied to substantially one side of a substrate for the purpose of heating the substrate and a processing fluid is applied to substantially the same side of the substrate has a number of disadvantages:

- the processing fluid is diluted by the heated liquid and the dissolved concentration is further reduced by that dilution; the reduction in concentration is a factor of two or more in Nelson's embodiments in which the heated liquid flow rate and the processing fluid flow rate are approximately equal.

- if the temperature of the processing fluid is reduced below ambient, then the processing fluid is further diluted by the heated liquid since the heated liquid flow rate must be

increased to transfer the additional energy to heat the substrate; this can substantially nullify any increased concentration that might be achieved by cooling the processing fluid below ambient.

- the heated liquid (heated DI water) is an additional consumable; in practical embodiments, the heated fluid flow rate is comparable to the flow rate and the volume of DI water used is increased by a factor of two or more.

- the application of a processing fluid and a heated liquid as separate streams to the substrate provides no means for monitoring the concentration and temperature of the processing liquid prior to application to the substrate since the processing fluid is both diluted and heated at the substrate; this significantly limits the users ability to monitor and closely control the process concentration and process temperature.

- the application of a processing fluid and a heated liquid as separate streams to the substrate does not provide for the flexibility in system design that is available with a heated processing liquid is applied to the substrate.

Further, if one attempts to overcome these limitations of the above Nelson process by applying a heated liquid to substantially one side of a substrate for the purpose of heating the substrate and applying a processing fluid to substantially the other side of the substrate to attempt to prevent mixing of the heated liquid with processing fluid, then one encounters a number of other problems:

- in <u>batch</u> wafer processing configuration, the application of a processing fluid to substantially one side of a substrate and the application of a heated liquid to substantially the other side of the substrate is not practical due to the close spacing of the substrates

- in any processing configuration, the application of a processing fluid to substantially one side of a substrate and the application of a heated liquid to substantially the other side of the substrate requires that the substrate be accessible from both sides during processing and significantly complicates the design of the chuck, for example, preventing the use of substrate holding chucks such as vacuum chucks and Bernoulli chucks that prevent access to the back side of the substrate

- in any processing configuration, the application of a processing fluid to substantially one side of a substrate and the application of a heated liquid to substantially the other side of the substrate requires that the substrate be accessible from both sides during processing and prevents the simultaneous application of processing fluid to both sides of the substrate

- in any processing configuration, the application of a processing fluid to substantially one side of a material and the application of a heated liquid to substantially the other side of the material is not possible for materials of complex or non-planar shape.

- in any spin processing configuration, the application of a processing fluid to substantially one side of a substrate and the application of a heated liquid to substantially the other side of the substrate to heat the substrate cannot insure uniform heating of the substrate because the boundary layer for heat transfer between the heated liquid and the substrate is not uniform with radius; (the radial variation in the boundary layer thickness when a liquid is applied to a spinning substrate is well documented in the literature); in addition the boundary layer between the heated substrate and the processing fluid will not be uniform with radius. This radial variation in heat transfer can lead to a radial temperature variation and radial variation in etch rate; some radial positions may have good heat transfer and some radial positions may have poor heat transfer; in cases in which the substrate is rotated about an axis of rotation which does not pass through the center of the wafer, the boundary layer thickness is again are not uniform over the wafer surface.

- in any spin processing configuration, the application of a processing fluid to substantially one side of a substrate and the application of a heated liquid to substantially the other side of the substrate to heat the substrate can not only not insure that the heat transfer conditions are uniform with radius, but cannot insure that the heater transfer conditions are the same when the speed of rotation is changed since the boundary layer thickness on each side of the substrate, and the heater transfer as a function of radius on each side of the substrate, will change if the rotation speed is changed.

- the use of a heated liquid applied to a substrate for the purpose of heating a substrate does not provide the means to optimize those heat transfer conditions and accordingly, the temperature difference required for a given heat transfer is larger and the heated fluid temperature must be larger.

For all of the above reasons, Applicants believe claim 1, as amended, is a significant improvement over the art, and in particular over the process described in the Nelson reference. Furthermore, Applicants believe that the claimed invention is not shown or suggested by the Nelson reference, or any other cited reference, or any combination thereof, and respectfully requests that the Examiner withdraw his rejection of claim 1, as amended.

With regard to the other claims pending in this application, the Examiner's rejection relied entirely on the rejection of original claim 1 under Nelson, or the rejection of claim 1 under Nelson in view of the Machino reference, or the Sehested el al reference. Applicants believe that those rejections are no longer relevant in view of claim 1, as amended, since the combinations provided in the other claims are not shown or suggested by any combination of the cited references.

Applicants have further add two new dependent claims, claims 121 and 122, as follows:

121. The method of claim 1, wherein said step of applying said heated ozone-solvent solution to said material comprises passing said heated ozone-solvent solution through an orifice that directs said heated ozone-solvent solution toward said

material, and wherein the step of heating comprises using a liquid-to-liquid heat exchanger placed just upstream of said orifice to heat said ozone solvent solution.

122. The method of claim 1, wherein said step of applying said heated ozone-solvent solution to said material comprises passing said heated ozone-solvent solution through an orifice that directs said heated ozone-solvent solution toward said material, and wherein the ozone-solvent solution is heated in the heating step using an in-line heater placed just upstream of said orifice.

In both of these new claims 121 and 122, it is clear that the processing liquid is heated before it is applied to the wafer and that the heating elements are used to heat the processing liquid (ozone-solvent solution), not some fluid that is used to heat the wafer.

With the above amendment, Applicants believe that claims 1-7, 9-15, 17-29, 31-37, 39, and 116, as amended, and new claims 121 and 122 are clear of the cited references and respectfully requests allowance of these claims and those that depend from them.

Respectfully Submitted
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